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Canadian Science Advisory Secretariat
Maritimes Region | Science Response 2018/022

STOCK STATUS UPDATE OF ATLANTIC HALIBUT (*HIPPOGLOSSUS HIPPOGLOSSUS*) ON THE SCOTIAN SHELF AND SOUTHERN GRAND BANKS IN NAFO DIVISIONS 3NOPs4VWX5ZC

Context

Atlantic Halibut (*Hippoglossus hippoglossus*) is the largest of the flatfishes and ranges widely over Canada's East Coast. The management unit definition, Northwest Atlantic Fisheries Organization (NAFO) Divisions 3NOPs4VWX5Zc, is based largely on tagging results that indicate that Atlantic Halibut move extensively throughout the Canadian North Atlantic with smaller fish moving further than larger fish.

The Atlantic Halibut fishery was unregulated until a Total Allowable Catch (TAC) was implemented in 1988 and a legal size limit (≥81 cm total length) was established in 1994. The Fisheries and Oceans Canada (DFO) Research Vessel (RV) Survey provides an index of abundance for incoming recruitment for the stock. An Industry-DFO Longline Halibut Survey (Fixed Station Halibut Survey) on the Scotian Shelf and southern Grand Banks (NAFO Divs. 3NOPs4VWX5Zc) was initiated in 1998 to provide an index of exploitable (≥81 cm total length) Atlantic Halibut on the Scotian Shelf and southern Grand Banks. A new assessment model and assessment procedures were adopted in November 2014 (Cox et al. 2016) to inform Resource Management of the status of the Halibut resource and to provide harvest level advice based on standardized catch rates from the Halibut Survey and stratified mean numbers-per-tow from the DFO Summer RV Survey (NAFO Divs. 4VWX). Science advice provided in December 2014, 2015 and 2016 used this new procedure (DFO 2015, 2017). In 2017, following the recommendations outlined in the 2014 Assessment Framework, a new Stratified Random Halibut Survey was initiated that extended the survey into areas and depths that were not well sampled by the Fixed Station Survey. This new Survey contains 15 strata, divided into 5 subareas, and three depth zones. One hundred and fifty stations (150) were randomly selected with allocations to strata proportional to their area. The Stratified Random Survey will not be used to generate science advice this year. To calibrate the Stratified Random Survey with the Fixed Station Survey, 100 Fixed Stations will continue to be fished for at least three years. These 100 stations were selected to provide index of abundance for the provision of science advice on Atlantic Halibut harvest level. The next Framework review is currently scheduled for 2019; however, the calibration period will not be complete by this time.

Resource Management asked Science to update and evaluate Atlantic Halibut abundance indicators, landings and fishing mortality estimated from tagging data. This response provides 2018-2019 TAC advice based on the Objectives and Harvest Strategy adopted at the Scotia-Fundy Groundfish Advisory Committee (SFGAC) meeting in March 2015.

This Science Response Report results from the Science Response Process of December 4, 2017, on the Stock Status Update of 3NOPs4VWX+5 Atlantic Halibut.

Background

Biology

Atlantic Halibut are most abundant at depths of 200-500 m in the deep-water channels running between the banks and along the edge of the continental shelf, with larger individuals moving into deeper water in winter. The geographic range of Atlantic Halibut in the Northwest Atlantic extends from the coast of Virginia in the south to the waters off northern Greenland.

Female Atlantic Halibut grow faster than the males and attain a much larger maximum size. Atlantic Halibut grow rapidly (approximately 10 cm per year) until the age of maturity, which for this region is estimated to be at 77 cm for males (Age 5-6) and 119 cm for females (Age 9-10).

Description of the Fishery

The management unit definition (NAFO Divs. 3NOPs4VWX5Zc, Figure 1) was based largely on tagging results that indicated that Atlantic Halibut move extensively throughout the Canadian North Atlantic. Within the management unit, Atlantic Halibut is fished mostly along the edges of the continental shelf and mainly by longline. Until 1988, the fishery was unregulated. A TAC of 3,200 metric tonnes (t) was first established in 1988 and was reduced to a low of 850 t in 1995, in response to an eight year decline in landings. Since 1994, management plans and licence conditions require the release of Atlantic Halibut less than 81 cm. Beginning in 1999, the TAC has been increased several times and was set at 3621 t in 2017 (Table 1; Figure 2).

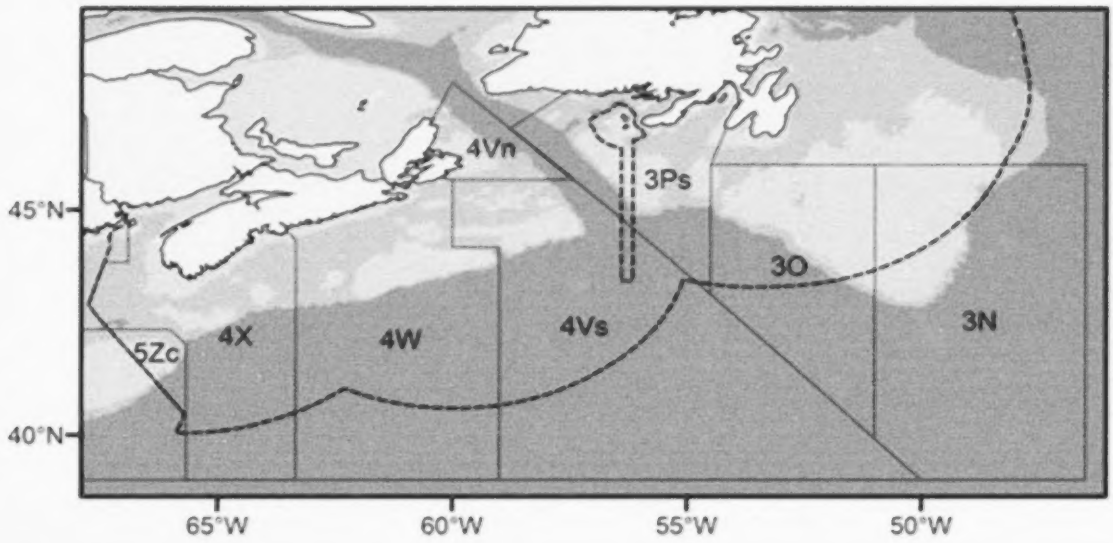

Figure 1. Management unit 3NOPs4VWX5Zc.

The NAFO statistics are used to describe removals up to 2015 because landings occur in two DFO regions (Maritimes Region and Newfoundland and Labrador Region), outside Canada's Exclusive Economic Zone (EEZ), and other countries including Portugal, Spain, France, and the US. Only the Canadian landings (MARFIS) are reported for 2017, and these numbers are preliminary. The majority of landings in 2016 occurred on the Scotian Shelf (NAFO Divs. 4VWX) and were very similar to those of 2015. As of November 28, 2017, the NAFO reported Spanish

landings in 3NO for 2016 are under review. To this end, the 2016 Spanish landings were estimated to be 90 t (communicated by NAFO), which results in a slight decrease in foreign landings for 2016 compared with 2015. It should be noted that, in some years, Canadian quota carry forward provisions and foreign catches result in landings above the TAC.

Table 1. Total reported Canadian and foreign landings (metric tonnes) of Atlantic Halibut from Northwest Atlantic Fisheries Organization Divisions 3NOPs4VWX5Zc[1]. Ten-year annual average landings are presented for 1960 to 2009.

		Landings			Landings[3]	Canadian TAC[4]
	Year(s)	3NOPs	4VWX	5Zc[2]	3NOPs4VWX5Zc	3NOPs4VWX5Zc
Decadal Average	1960-69	996	1464	-	2460	-
Decadal Average	1970-79	487	[illegible]	-	1338	-
Decadal Average	1980-89	955	1561	50	2566	-
Decadal Average	1990-99	503	790	30	1323	1855
Decadal Average	2000-09	607	863	15	1484	1318
Annual	2010	595	1279	11	1885	1850
Annual	2011	591	1322	19	1932	1850
Annual	2012	731	1460	29	2220	2128
Annual	2013	767	1799	33	2599	2447
Annual	2014	1151	1779	22	2952	2563
Annual	2015	1088	2148	19[5]	3262	2738
Annual	2016	1071	2154	26	3263	3149
Annual	2017[6]	370	2026	28	2424	3621[7]

[1] Landings 1960-2016 from NAFO Table 21A as of September 13, 2017.
[2] Landings were first listed in 5Zc in 1986.
[3] NAFO Table 21A reported by calendar year.
[4] Total Allowable Catch (TAC) set for April-March fishing year for Canadian commercial fishery. Prior to 1988 the Atlantic Halibut catch was unregulated.
[5] In 2015, NAFO attributed 5Zc landings to 5Ze.
[6] Landings from the Maritimes Fisheries Information System (MARFIS) for 2017 are preliminary, as of November 28, 2017.
[7] For 2017, 100 t of the Canadian TAC were set aside to cover catches by US and France within the stock area.

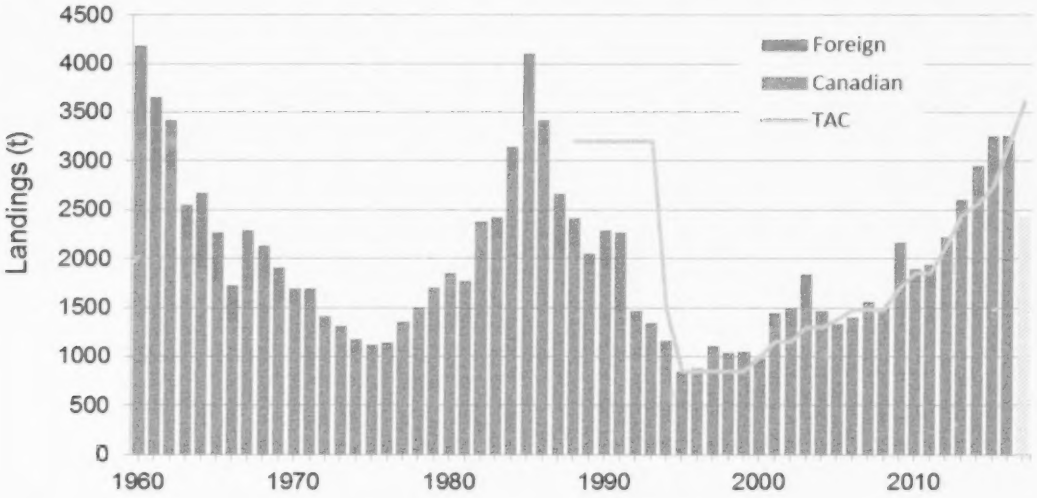

Figure 2. Northwest Atlantic Fisheries Organization (NAFO) reported Canadian (blue) and foreign (red) landings (metric tonnes) for 3NOPs4VWX5Zc Atlantic Halibut. Landings for 2017 (hashed bar) are preliminary, and taken from the Maritimes Fisheries Information System (MARFIS) as of November 28, 2017. The solid green line is the Canadian Total Allowable Catch (TAC). The NAFO 21A table of landings by country are reported by calendar year; however, the TAC for the stock is set for the period of April-March.

Assessment Framework

A new Assessment Framework was adopted in November 2014 (Cox et al. 2016). This Framework used a new statistical catch-at-length (SCAL) model to assess the stock status and an operating model (HAL) to evaluate the impact of a suite of harvest strategies on the biomass/population trends and landings. In March 2016, the SFGAC adopted an F=0.14 harvest strategy with a cap on annual changes in TAC of 15%. Stock status in interim years is assessed based on the Halibut Survey index of exploitable biomass and the DFO Summer RV (NAFO Divs. 4VWX) Survey. The next Assessment Framework review is currently scheduled for 2019. However, if the DFO Summer RV (NAFO Divs. 4VWX) Survey index falls below the long-term mean in three of the most recent five years, an earlier than anticipated framework review could be triggered. In interim years, Science advice on TAC is based on the 3-year mean Halibut Survey index of exploitable biomass.

Analysis and Response

4VWX Research Vessel Survey

The DFO Summer RV Survey (NAFO Divs. 4VWX) has been conducted every July since 1970. The median size of Halibut caught in the trawl survey is between 40 and 50 cm. The catch of Atlantic Halibut in this survey increased between 2000 and 2011 (Figure 3). Since 2011, catch rates have remained above the long-term mean, and mean numbers per tow in 2017 were essentially identical those in 2016. The RV survey mean numbers per tow in 2017 are tied for fifth highest in the last 10 years.

The biomass index from the RV survey is at the highest level in the time series (DFO 2018), reflecting the greater number of large fish in the survey. No Halibut less than 38 cm were caught in the survey, indicating that there may have been a couple of years of poor survival of early life history stages.

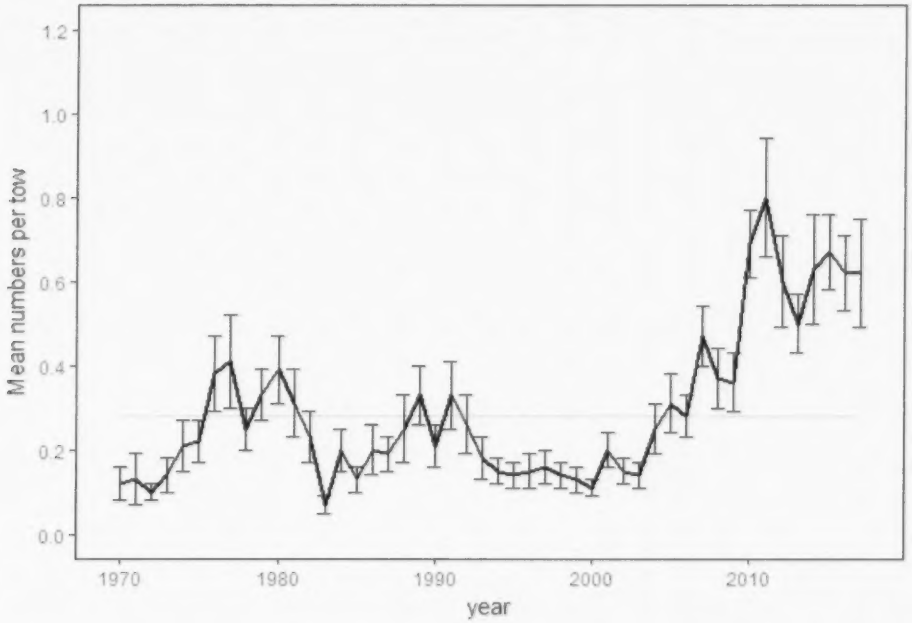

Figure 3. Plot of mean number of Atlantic Halibut per tow for DFO Summer Research Vessel Survey sets in 4VWX from 1970 to 2016. The grey horizontal line is the long-term (1970-2016) mean (mean=0.28 per tow). The vertical bars indicate 95% confidence intervals.

Fixed Station Halibut Survey

The Fixed Station Halibut Survey provides an index of abundance of Atlantic Halibut ranging in size between 50 and 220 cm (den Heyer et al. 2015). The survey is completed by commercial fishermen with onboard observers between May and August. Halibut Survey catch rates were standardized using a Generalized Linear Model (GLM) including both station and year effects. In 2017, the number of stations surveyed during the Fixed Station Halibut Survey was reduced from the approximately 232 consistently fished stations to 100 stations. This allowed more effort to be directed towards the new Stratified Random Survey, while providing adequate sampling to both provide an index of exploitable biomass and to calibrate the Stratified Random stations to the Fixed Stations. The catch rate has increased since 2004, with the 2017 standardized catch rate from the GLM fit to the 100 Index Stations being the highest in the 20-year time series (Figure 4 and 5). The 2017 3-year mean of exploitable biomass from the Halibut Survey is 35% higher than 2016, and 60% higher than 2014, the last year the stock was assessed.

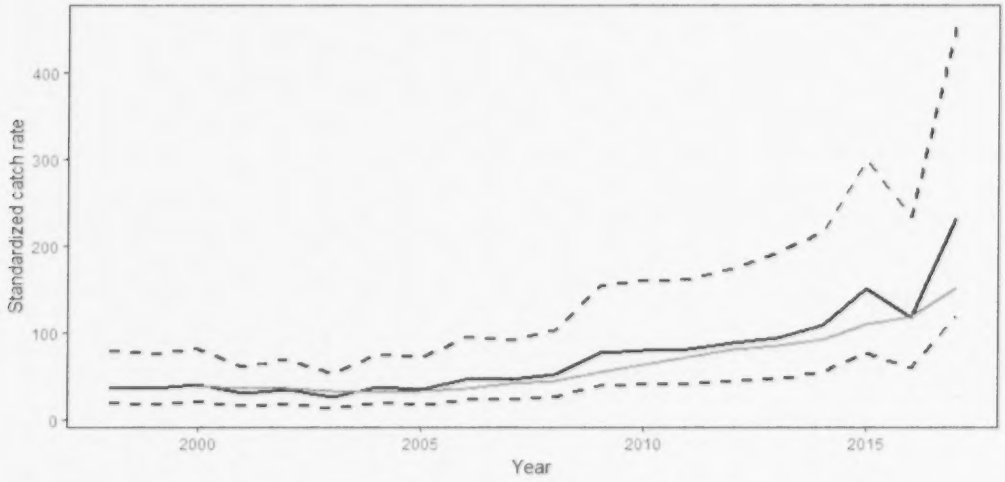

Figure 4. Plot of standardized catch rate of Atlantic Halibut (kg/1000 hooks/10 hrs) from the Generalized Linear Model (GLM) of 3NOPs4VWX Halibut Survey 100 Index Stations. The solid black line is predicted catch rate; the dashed lines indicate the 95% confidence interval. The 3-year mean of the index (solid red line) is also plotted.

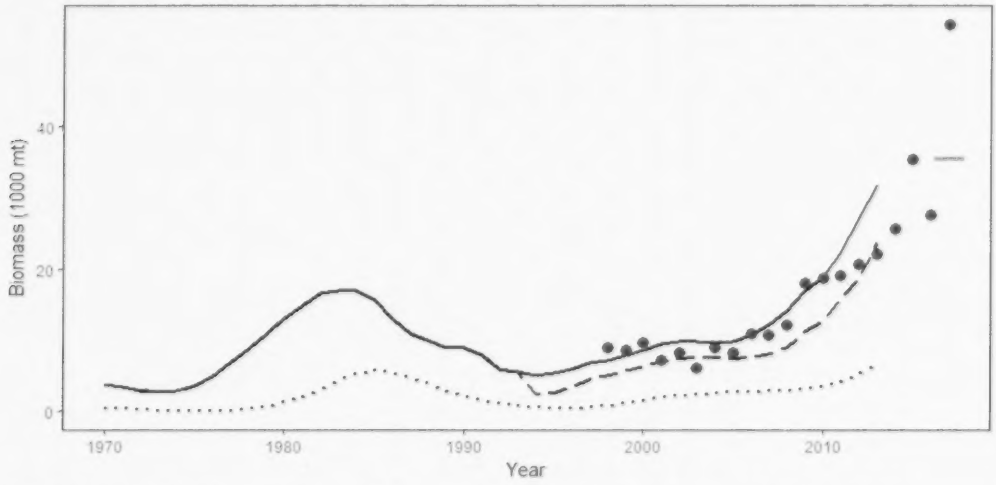

Figure 5. Plot of Atlantic Halibut biomass between 1970 and 2013 estimated from the stock assessment model (black lines) and the Halibut Survey 100 Index Stations (blue circles). The solid black line is total biomass, the dashed line is legal biomass, and the dotted line is spawning stock biomass. The solid red bar is the current 3-year mean of the Halibut Survey biomass index.

Harvest Control Rule

Applying the F=0.14 strategy with a maximum change of 15% from the 2017 TAC (3621 t) results in an increase in the 2018-2019 TAC to 4164 t, which represents the maximum yearly increase of 15%. This application of the harvest control rule, and the projections from the HAL model (DFO 2016), assume all removals from Canadian and international fisheries are included.

Multi-year Mark-recapture Tagging Model

In 2006, DFO and the Atlantic Halibut Council (AHC) began the Halibut All Sizes Tagging (HAST) program to estimate population size, exploitation rate and evaluate the distribution of Atlantic Halibut within the Scotian Shelf southern Grand Banks management unit (den Heyer et al. 2015). In this program, tagging occurs every other year, and no tagging was conducted in 2017. Between 2006 and 2014, 4,573 Halibut were double tagged with T-bar anchor tags. As of December 31, 2016, 831 tagged Halibut were recaptured and reported with sufficient information to be used in the multi-year mark-recapture model. Assuming 80% tag reporting and 100% survival from tagging, fishing mortality (F) is declining from a high of 0.18 in 2008 to a low of 0.04 in 2016 (Figure 6). The absolute estimates of F from the tagging model are not directly comparable to the assessment model, but provide an indication of trend in interim assessment years.

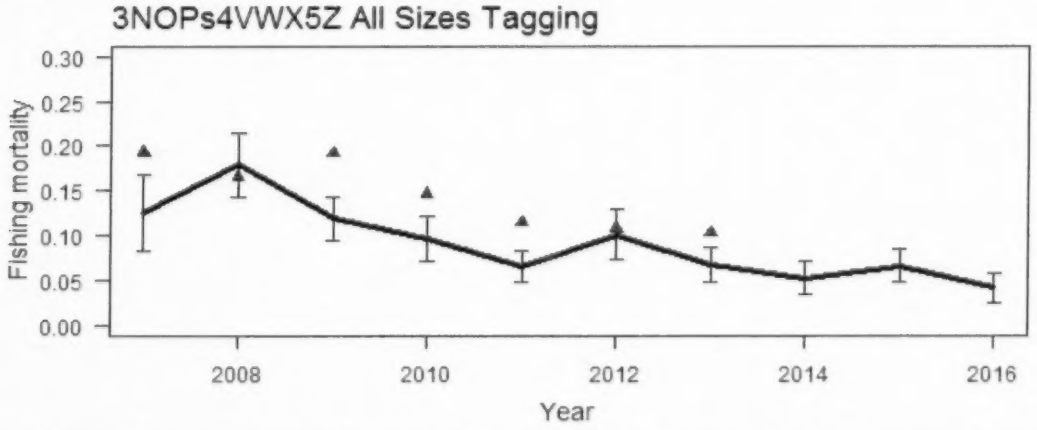

Figure 6. Plot of instantaneous fishing mortality for Atlantic Halibut estimated from the multi-year tagging model (solid black line) and the assessment model (blue triangles). The vertical bars indicate 95% confidence intervals.

Conclusions

The 3NOPs4VWX5Zc Atlantic Halibut stock has a history of overfishing that predates the time series used in the stock assessment model (i.e. prior to 1970). The assessment model indicates that the stock has increased from the depleted state observed in the early 1990s. The updated 3NOPs4VWX5Zc Halibut Survey index shows that abundance of exploitable (>81 cm) Halibut continues to increase with 2017 being the highest in the 20-year time series. The 2017 DFO Summer RV (NAFO Divs. 4VWX) index remains above the long-term mean, and the 2017 mean numbers per tow were the fifth highest in the last 10 years. However, no Halibut < 38 cm were caught in the survey, suggesting recruitment may have been low for some year classes. Consistent with the rapid increase in biomass and a capped increase in TAC, fishing mortality, estimated from the multi-year mark-recapture model, has declined slightly. The 3-year mean index of exploitable biomass for 2017 is 35% higher than last year. A TAC consistent with the Harvest Strategy adopted by the SFGAC for 2018 is 4164 t, which is the maximum yearly change in TAC of 15% (543 t).

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Sources of Information

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